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# HYDRAULIC SYSTEM CLEANING PROCEDURES, METHODS, AND CRITERIA

HYDRAULIC CLEANING PROCEDURE									
SIZE	FSCM NO.		WT GRP	NAVSEA DRAWING NO.				REV	
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# HYDRAULIC SYSTEMS CLEANING PROCEDURES, METHODS AND CRITERIA

## 1.0 SCOPE

The purpose of this drawing is to establish the requirements for cleaning shipboard hydraulic systems. This drawing may be invoked for cleaning an entire system which has been contaminated or for cleaning a portion of a system after repairs or modifications.

## 2.0 REFERENCES

- 2.1 S9AA0-AB-GOS-010/GSO, General Specs for Overhaul
- 2.2 S9086-S4-STM-000, Naval Ship's Tech Manual, Chapter 556
- 2.3 MIL-STD-419, REV D, Cleaning and Protecting Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment
- 2.4 NAS 1638, Cleanliness Requirements of Parts Used in Hydraulic Systems

## 3.0 DEFINITIONS

- 3.1 LEVEL II CLEAN -- A degree of cleanliness that results in a surface visually free of grease, oil, flux, scale, dirt, loose particles and any other contamination foreign to the base metal. Tap water residues on all metals and light superficial rust on carbon steel surfaces caused by short time exposure to the atmosphere, are permitted. Light dust on cleaned surfaces is not objectionable, provided that the quantity and size of the particles do not adversely affect system operation.

- 3.2 REYNOLDS NUMBER -- A dimensionless number which describes the nature of flow in pipe. Reynolds number equals flow rate divided by viscosity and pipe diameter.

$$\text{Reynolds Number} = \frac{(3160) (\text{flow rate in gallons/minute})}{(\text{kinematic viscosity in centistokes}) (\text{pipe I.D. in inches})}$$

Flow is considered turbulent for Reynolds numbers greater than 4000.

- 3.3 FLUSHING RIG -- Machinery consisting of pump and motor, filter, and heater capable of providing hydraulic flow for flushing. Unit must be capable of providing sufficient flow to obtain Reynolds Number greater than 4000 in pipe to be flushed.

#### 4.0 GENERAL REQUIREMENTS

- 4.1 The Hydraulic system must be maintained Level II clean as defined above.
- 4.2 Sump tanks, storage tanks, reservoirs, etc shall be opened and hand cleaned to Level II cleanliness. Cleanliness shall be confirmed by visual inspection.
- 4.3 Pumps, motors, valves, cylinders, accumulators, and any other components which cannot be cleaned by flushing shall be disassembled and cleaned. Components must be reassembled in a clean environment to ensure Level II cleanliness of all internal surfaces and components. After assembly all openings must be capped and equipment protected from contamination until reinstalled in system. Sealing and capping shall be as specified in Reference 2.3.
- 4.4 If components are not to be installed in system immediately after cleaning, coat internal surfaces with system fluid or preserve as specified in Reference 2.3.
- 4.5 Any new components to be installed in system must be verified clean prior to installation.
- 4.6 Piping shall be cleaned by tank cleaning in shop, flushing individual pieces which have been removed from system, or by flushing in place.
- 4.7 New piping must be pickled prior to installation as specified in Reference 2.3. Pickling is not required to clean existing installations during repair or modification unless the pipe or tube has internal oxide scale that cannot be removed by wire brush, water jet, or flushing.
- 4.8 Hydraulic system cleaning procedure will generally be accomplished as follows. Exceptions and variations may be required to suit the specific system being cleaned.
  - 4.8.1 Clean sumps, tanks, and components which cannot be flushed.
  - 4.8.2 Flush piping as specified below until fluid sample meets acceptance requirements.
  - 4.8.3 Remove jumpers and reconnect system pumps and other components to return system to normal configuration.
  - 4.8.4 Install new filter elements in system.
  - 4.8.5 Operate system cycling through all normal modes of operation. Continue operating system for a minimum of two hours or until fluid samples meet final acceptance criteria.
- 4.9 Fluid samples shall be taken from circulating system fluid and from low points of tanks, piping, accumulators, etc., where contaminants are likely to settle. Samples are to be analyzed for water content, particulate contamination and other detrimental conditions. Fluid shall meet the requirements of Section 6.0 below.

## 5.0 FLUSHING

- 5.1 Flushing of system shall be as specified in Reference 2.3.
- 5.2 Entire hydraulic system shall be flushed. System should be separated into individual loops which may be flushed at required flow rate without exceeding maximum safe pressure for system piping.
- 5.3 Jumpers and/or temporary piping shall be used to bypass components which cannot be flushed and to facilitate connecting flushing loops. Jumpers and temporary piping should meet Level II clean prior to installation.
- 5.4 Flush with system fluid.
- 5.5 Flush with flow rate sufficient to achieve Reynolds number greater than 4000 in each section of piping.
- 5.6 Flush with filtration of 25 microns absolute or less. Flushing filters shall be in accordance with MIL-F-24402 or equal. Change filter elements when differential pressure exceeds 5 psig.
- 5.7 When normal system flow may be in either direction in a pipe, that loop shall be flushed in both directions.
- 5.8 Heater shall be provided to heat flushing oil. Flush at approximately 140 degrees Fahrenheit. Note that viscosity of oil changes with temperature -- flush must be performed at or higher than the temperature that was used for calculating required flow rates.
- 5.9 Ball checks and springs shall be removed for flushing, externally cleaned and reinstalled after flushing.
- 5.10 Dead ends which cannot be through flushed shall be cleaned independently.
- 5.11 Flush each piping loop for a minimum of one hour and until a sample meets requirements specified in 6.0 below.
- 5.12 Flow rate in each loop shall be verified by a calibrated flow meter installed downstream of Flushing Rig.
- 5.13 A relief valve shall be installed between the Flushing Rig and the loop being flushed to ensure that maximum safe pressure is not exceeded in any pipe or jumper.

## 6.0 ACCEPTANCE CRITERIA

### 6.1 Fluid samples shall meet the following criteria.

- 6.1.1 Particle count shall meet or exceed Class 9 standard for particles 15 microns and greater in accordance with Reference 2.4.
- 6.1.2 Water content shall not exceed 0.05 % by volume. If water cannot be removed by appropriate procedure, contaminated fluid shall be drained and replaced with clean fluid.
- 6.1.3 There shall be no obvious degradation or loss of desired physical or chemical characteristics. Degraded fluid shall be drained and replaced with clean fluid.

### 6.2 Level II clean requirement shall be visually confirmed by contractor's Quality Assurance representative and Supervisor of Shipbuilding representative.

## 7.0 DOCUMENTATION

### 7.1 Prior to commencing flush, contractor shall submit a procedure to the Supervisor of Shipbuilding for approval. Procedure shall provide the following information.

- 7.1.1 Flushing Rig and other equipment to be used.
- 7.1.2 Sketch of hydraulic schematic for flushing including individual loops to be isolated and flushed.
- 7.1.3 Flow rates to be used in each loop. Flow rates based on Reynolds number of 4000 calculated using flushing oil to be used at minimum temperature to be maintained.
- 7.1.4 List of sign offs and/or Q. A. plan to ensure compliance with the requirements listed herein.

### 7.2 Contractor shall submit reports of final oil analysis to the Supervisor of Shipbuilding.

### 7.3 Contractor shall submit copies of completed sign off sheets, Q. A. forms, etc. to the Supervisor of Shipbuilding after completion of flush.